DOCUMENT RESUME

ED 241 176 PS 014 223

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TITLE Young Children's Use of Spatial Context in Memory.
PUB DATE Mar 79
NOTE 29p.; Paper presented at the Biennial Meeting of the Society for Research in Child Development (San Francisco, CA, March 15-18, 1979).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Age Differences; Cues; *Preschool Children; Preschool Education; *Recall (Psychology); *Spatial Ability
IDENTIFIERS *Context Effect; *Spatial Context

ABSTRACT

Two studies were conducted to determine whether preschool children automatically use spatial context to aid recall of objects or whether the ability to use spatial context as a retrieval aid is a deliberate mnemonic strategy that develops later. In the first experiment, a total of 32 children (16 aged 3 and 16 aged 4) participated in a memory task under three conditions varying in type of recall (free or cued) and in the presence or absence of spatial context. Spatial context was found to facilitate older children's recall of items. In the second experiment, the sample size was increased to 48. Children participated in a training procedure in which they labelled 13 large toy props that had stable spatial locations in a small playroom. After the subjects' play with the objects was recorded, the children were brought out of the room, and the objects were removed. Subjects were brought back to the room and were asked to recall the missing items under one of two conditions (with spatial context either present or absent). After the recall task, children were encouraged to find the missing items and to help return them to their original locations. Results indicated that the mean number of objects recalled was greater for both older and younger preschoolers when they recalled within the spatial context than when they did not. (RH)

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ED241176

Young Children's Use of Spatial Context in Memory

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Acknowledgments

The authors thank the staff at the University of Texas Child and Family Laboratory for their support and cooperation. We also thank Kim Lyman, Kim Neubecker, and Georgia Smith for their help in data collection, and Bill Swann for helpful comments. A version of this paper was presented at the meeting of the Society for Research in Child Development, San Francisco, March 1979. Reprint requests should be sent to Nancy L. Hazen, Department of Home Economics, Division of Child Development and Family Relationships, the University of Texas, Austin, Texas 78712.

PS 014223

Running Head: Spatial Context in Memory

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Young Children's Use of Spatial
Context in Memory

Since the ancient Greeks, people have been aware that is is easier to remember items and events that have been associated with distinctive spatial locations. The classic "method of loci" was designed to take advantage of this principle (Yates, 1966; Bower, 1970). The memorizer mentally associates a series of items or events to be recalled with distinctive locations along a well-known route. In more recent times, experimental studies (e.g., Bower, 1970) have attested to the mnemonic effectiveness of the "method of loci." Subjects trained to use if often recall two to seven times as much as control subjects.

The effectiveness of the method of loci indicates that recall of information is likely to be facilitated when that information is encoded and retrieved within a stable spatial context. Because the method of loci involves imagining lists of items within spatial contexts where they are not actually found, it is not a commonly used mnemonic strategy and does not develop spontaneously i.e., without explicit instruction, as do strategies such as categorical clustering or rehearsal. There is evidence, however, that in fact the spatial context in which information is actually encountered automatically provides adults with productive cues for the recall of that information. For example, Smith, Glenberg, & Bjork (1978) found that adult subjects recalled more words from a word list when the recall task was presented in the same room in which the list was learned than when the recall task was presented in a different but equally familiar room. The purpose of the present studies was to examine if the presence of the spatial context in which items were encountered facilitates recall even in young children, or if the ability to use spatial context as a retrieval aid is a deliberate mnemonic strategy which develops only later.

Several recent studies indicate that humans are quite sensitive to spatial location, and tend to recall it even when it is irrelevant to the

task. For example, Rothkopf (1971) and Zechmeister & McKillup (1972) found that readers could remember the location of information on a printed page at a level well above chance, even though they were not instructed to do so and could derive no benefit from doing so. Data such as these have led Hasher and Zacks (1979) to conclude that spatial information is encoded automatically. According to Hasher and Zacks, automatic cognitive processes are involuntary and occur without intention or cognitive effort. Thus, they are affected little by practice, and show little developmental change. Automatic processes in memory include those for which humans are genetically prepared. These processes are likely to encode the most fundamental aspects of events - spatial, temporal, and frequency-of-occurance information. Hasher and Zacks contrasted these automatic processes with effortful processes such as rehearsal, elaborative strategies, and clustering, which do benefit from practice, change with development, and require considerable attention and intentional cognitive control.

If spatial location is indeed encoded automatically, then the spatial context in which items are found ought to provide useful retrieval cues for recalling these items, even for very young children. Spatial location does indeed appear to be easily encoded at an early age. One of the easiest types of memory tasks for toddlers and young preschool children are delayed-response tasks, in which children are required to recall the spatial location of hidden objects (DeLoache, 1980). Even infants as young as 9 months old are able to use direct, salient landmarks to locate hidden objects (Acredolo & Evans, 1980).

Although it is true that developmental improvement in children's memory for location has been found consistently (e.g., Acredolo, Pick, & Olson, 1975; Herman & Siegel, 1978; Liben, Moore, & Golbeck, 1982), such

developmental improvements appear to be due primarily to developmental changes in cognitive abilities to represent spatial relations. Much research and theory on the development of spatial cognition indicates that preschool-aged children cannot coordinate locations of objects within a space using Euclidean spatial relations, but instead rely upon topographic cues to locate objects (Piaget & Inhelder, 1956; Siegel, 1981). Young children are thus able to encode object locations as accurately as older children when locations are marked directly by distinctive landmarks, but the fewer distinctive topographic cues in a space, the less quantitatively accurate young children's memory for locations is likely to be. Nevertheless, accurate encoding of object location would not seem to be essential for spatial context to aid object recall effectively.

If young children do encode automatically the spatial locations of objects, at least in a qualitative sense, can they actually use spatial context to aid their recall of the objects? Or must the knowledge that spatial context can be used as a retrieval aid, and the knowledge of how to use spatial context as a retrieval aid, be acquired later in development? These questions were investigated in Experiments 1 and 2.

EXPERIMENT 1

Results of a study by Myers and Perlmutter (1978) seem to indicate that preschool children do not recall more objects when the spatial context in which the objects were learned is present than when it is not present. In two conditions of the study, the experimenter removed each object to be recalled from a large box, labeled it, and placed it inside a particular box in a 3 x 3 array of compartments. In one condition, the array of compartments was not present during recall, and in the other condition it was. Children

aged 3- and 4- years recalled equal numbers of objects in both of these conditions. Nevertheless, the purpose of the study was to see if preschool children could use the array of boxes to instigate more strategic search. Thus, it may not be well suited to examining whether the spatial context in which objects are hidden provides retreival cues for recall of the objects, because the children may not have associated the objects they were to recall with the particular spatial locations in which they were finally placed. The objects were not initially seen in the 3 x 3 array, and were not placed within the array until the end of the learning period. Experiment 1 is similar to the Myers and Perlmutter (1978) study, except that each item to be recalled was left in a particular spatial location during all phases of the study. Also, in addition to comparing the effects of presence versus absence of spatial context on the number of items recalled, two different conditions in which spatial context was present were compared - a cued recall condition, in which children were asked to recall the item hidden at each successive location, and a free recall condition, in which children were simply asked to recall as many items as they could.

Method

Subjects. Sixteen 3-year-old children (7 males and 9 females) and 16 4-year-old-children (7 males and 9 females) participated in this study. All attended the University of Texas Child and Family Laboratory Preschool. The mean age of the 3-year-olds was 41.0 months (range = 43-38 months), and the mean age of the 4-year-olds was 55.7 months (range = 59-52 months).

Design. The design was a 2(age) x 2(sex) x 3(condition) factorial in which the last factor was a within-subjects variable. All 32 children

participated in each of the three conditions, memorizing a different set of pictures each time. The order of conditions and the order of picture sets used were counterbalanced across subjects. Children participated in the three memory conditions in separate sessions at least two weeks apart, in order to minimize practice effects or interference from learning previous picture sets.

Materials. The items to be remembered were three sets of nine colored line drawings of familiar objects and animals. All were obtained from preschool lotto games. The three sets of drawings were pretested to ensure that they were all equally familiar and easy to label for preschool children. Each set of nine line drawings was presented in a 3 x 3 array of plastic yellow boxes mounted on a plywood board. The array measured 60 cm x 60 cm and each box measured 10.5 cm x 6.5 cm. Each box had a lid which could later be closed.

Procedure. All children were tested individually by a female experimenter. The training procedure was the same in all three conditions. The child sat in a chair opposite the array of boxes, which were opened so that the pictures were clearly in view. The experimenter sat beside the child and asked the child to name the pictures. Any labels the child chose to use were accepted. The experimenter then said, "Let's name them again, so you'll remember all the pictures really well." The pictures were named three times, to insure that the child had attended to all of them, and to ascertain the labels that the child would use in later recall. The experimenter then let the child help her close the boxes.

After a 45-second delay, during which the experimenter engaged the child in irrelevant conversation, the testing procedure began. In Condition 1 (Free Recall - Spatial Context Absent), the experimenter removed the array of boxes from the testing room during the delay. She then returned to the testing room and, following the delay, asked the child, "Tell me all the

pictures you can remember that were in those boxes." In Condition 2 (Free Recall-Spatial Context Present), the procedure was exactly the same as in Condition 1, except that the array of boxes, with lids closed, was left in front of the child. The same recall instruction was given. The child was not asked to indicate the locations of the pictures. Condition 3 (Cued Recall - Spatial Context Present) was like Condition 2 in that the array of closed boxes was left in front of the child, but different in that the experimenter cued each location when eliciting recall of the picture. She pointed to each box in succession and asked, "What was in this box?" The lids of the boxes were not opened until the testing procedure was over. In Conditions 1 and 2, this occured when children said that they were sure they could not remember any more of the pictures. In Condition 3, the testing procedure ended after the experimenter had cued each of the nine boxes.

Results and Discussion

As shown in table 1, the mean number of pictures recalled by the younger group was about the same in all three conditions, but the older group clearly recalled more pictures in Condition 2, in which the spatial context was present and free recall rather than cued recall was permitted. Also, the recall performance of the older group was superior to that of the younger group only in Condition 2. These findings were confirmed by a 2(age) x 2(sex) x 3(condition) analysis of variance in which the last factor was a repeated measure. There was a significant main effect for condition, $F(2,56) = 4.95$, $p=.01$, as well as a significant age x condition interaction, $F(2,56) = 4.73$, $p=.01$. The main effect for age approached but did not reach significance, $F(1,28) = 3.33$, $p=.08$. There were no significant main or interactive effects of sex.

the older children. All of the children, except for two of the younger ones, spontaneously referred to the spatial context during recall by frequently pointing to the boxes which contained particular pictures as they recalled those pictures. They did this even though the experimenter did not ask them to indicate location or refer to the array of boxes in any way.

If children recalled a picture, they usually recalled that picture's location correctly as well. When the array of boxes was present and free recall was permitted, the younger group pointed to the pictures' locations for 73% of the pictures they recalled, and 96% of the time they specified these locations correctly. The older children in this condition specified locations for 84% of the pictures they recalled, and 99% of these were specified correctly. These results support Hasher and Zack's (1979) hypothesis that when items are encoded in memory, the spatial locations of these items are encoded automatically, without extra cognitive effort. Therefore, the presence of the spatial context in which items were encoded should provide retrieval cues to facilitate recall of the items, even for young children.

If this is the case, however, why did Condition 3, in which each spatial location was cued, fail to facilitate children's recall? And given that the younger children correctly encoded so many picture locations in Condition 2, why did the presence of the spatial array facilitate recall only for the older children?

One reason why Condition 3, the Cued Recall condition, did not facilitate children's recall may have been that the facilitating effect of the spatial context was offset by the potentially more demanding task of being required to recall <u>both</u> the identities and the locations of the 9 pictures. But if the picture locations were encoded automatically, recalling locations

should not require extra effort. Indeed, in Condition 2, in which older children recalled the greatest number of pictures, they also recalled spontaneously the locations of nearly all the pictures. The reason for the difficulty of the Cued Recall condition, then, probably lies with the imposed order of recall rather than with the requirement to recall both identity and location of the pictures. It may be that the children automatically associated each picture with a specific spatial location, but did not organize the whole array of pictures in memory by using a spatial representation corresponding to the layout of the spatial array which contained the pictures.

This interpretation is consistent with much of the literature on the development of children's cognitive representation of large-scale environments, which indicates that children initially represent spatial information in terms of fragmented and isolated relationships between landmarks, and only later develop the ability to organize and structure these landmarks into routes and configurations (Siegel & White, 1975; Hazen, Lockman, & Pick, 1978). Accordingly, the cued recall condition may have failed to facilitate recall because children were required to order their recall following an imposed organization that did not correspond to the organization of the information in memory. In support of this hypothesis, we found that only one younger and four younger children spontaneously used a systematic, route-like linear order when recalling the pictures in Condition 2, when the array of boxes was present, and only one older child did so in Condition 1, when the array was absent. Thus, the results of Experiment 1 indicate that preschool children do seem to automatically encode spatial location, and at least by the age of 4 years, are able to use location as a retrieval cue. However, they generally seem to encode isolated relationships between objects and locations rather than encoding objects within an organized mental representation corresponding to the spatial context in which they were presented.

There are at least two possible explanations for why the younger group did not recall more pictures in the Free Recall-Spatial Context Present condition. One possibility is that, even though they may have automatically encoded the relationships between the pictures and their locations, they did not think of the possibility of using the spatial locations of the pictures as retrieval cues, whereas the older children did. However, this explanation implies that using spatial context for retrieval is a conscious, deliberate memory strategy, and if so, it would seem unlikely that the older preschoolers would have been able to use it successfully either. The fact that both age groups referred spontaneously to picture location during free recall seemed to indicate that attention to spatial context automatically facilitates retrieval.

A second, more likely explanation is that features of this particular task did not permit spatial context to function as a retrieval aid for the younger children as it would in more naturalistic situations. First, the spatial contexts of the individual pictures were differentiated only by location, whereas naturalistic spatial contexts are differentiated by a variety of landmarks. Second, in naturalistic settings, recall occurs not only in differentiated spatial contexts, but in the context of meaningful events in which the child has particular goals. Perhaps even very young children are able to use spatial context as a retrieval cue in naturalistic, large-scale environments, particularly when the recall task is done within the context of a meaningful event, before they are able to do so in redundant, small scale spaces for less meaningful purposes. We examined this possibility in Experiment 2.

EXPERIMENT 2

Soviet theory and research in memory development indicates that the preschool child's memory is primarily involuntary and nonstrategic, dependent

upon the goals and activities of the child within real-life situations (Smirnov & Zinchenko, 1969). In Experiment 2, we sought to maximize preschool children's opportunity to use spatial context as a retrieval aid by presenting the recall task in a naturalistic, large-scale environment as part of a meaningful pretending activity.

In addition to its major purpose of providing a fairer test of the hypothesis that even very young children can use spatial context as a retrieval aid, Experiment 2 had two additional purposes. First, we wanted to examine more directly the link between memory for objects and memory for the location of those objects. In Experiment 1, we noted that when children were permitted free recall in the presence of the spatial context of objects, they usually indicated spontaneously the locations of these objects as well. However, we did not independently assess children's memory for object location and object identity. In this study, memory for the objects themselves and memory for object locations were assessed independently, so we could examine whether children remembered the location of recalled objects better than non-recalled objects, and whether they were more likely to recall objects that they could correctly locate than objects that they could not correctly locate. Second, since preschool children's recall seems to be closely linked to their activity, we wanted to examine the relationship between the extent to which children used particular objects, and the extent to which they were able to recall the objects themselves and the objects' locations.

Method

Subjects. Twenty-four 3-year olds (8 males and 8 females) and 24 4-year-olds (8 males and 8 females) participated in this study. All

attended the University of Texas Child and Family Laboratory Preschool. The mean age of the younger group was 44.6 months (range = 39 to 50 months, and the mean age of the older group was 55.3 months (range = 51 to 62 months).

Environment and Materials. The experimental procedure took place in a small playroom, 3.25 m. x 3.82 m. The playroom contained a table with two chairs, a chest of drawers, a throw rug, and 13 fairly large toy props (e.g., a doll bed, toy ironing board, large beanbag chair, mailbox, cage with toy animals, etc.) that had stable spatial locations, since they were generally too large for the child to move. The playroom was contained inside a larger research room which was sectioned off into smaller areas. Outside the large research room was a waiting area with a table set up with water color paints and paper.

Procedure. All children were tested individually by a female experimenter. During the training procedure, the experimenter took the child around the room and asked the child to label each of the 13 large toy props that had stable spatial locations. This was done to insure that the child attended to all of the objects, and to ascertain the labels that the child would use in later recall. The experimenter then initiated pretend play with the child, suggesting, "We can pretend this is our house." As much as possible, the experimenter then followed along with the child's play suggestions, so that the child was free to explore the objects in the room and play with whichever ones he or she preferred. A female observer who was familiar to the child sat in a corner of the playroom and recorded the frequency with which the child played with the various objects.

After 5 minutes of free play, the experimenter informed the child that it was time for them to "go to work," and that their job would be to "make a pretty picture to decorate our house." The experimenter and child then went to

the area outside of the large research room, where the child painted a picture. While the child and the experimenter were outside the research room, the observer moved the 13 large toy objects from the playhouse to a seperate enclosure within the large research room. The dresser drawers, rug, and table and chairs were left to provide a topographic frame of reference, along with the walls of the playroom, for recalling and relocating the 13 objects. After 5 minutes, the observer told the experimenter and the child that it was time to return to the playroom.

When the experimenter and child returned to the room, the experimenter said, "Oh, look! Everything is gone! We need to make a list of everything that's missing so we'll know what to look for." Half of the children in each age group were in recall Condition 1 (Spatial Context Present); the other half were in recall Condition 2 (Spatial Context Absent). Children in Condition 1 sat at the table inside the playroom while the experimenter made a list of all the objects the children recalled. Children in Condition 2 returned to the table outside of the large research room to recall the objects.

After the children had recalled all they could, the experimenter told children in both conditions that they could now look around the large research room to try to "find" the missing objects. The area in which all 13 objects had been placed was easily found, and the experimenter then asked the child to "help me fix our house exactly the same as it was." The experimenter carried most of the objects for the child, or helped the child carry them, and the child was told to direct the experimenter to the exact spot where each object should be replaced. Objects were replaced in a random order. After all objects were replaced, children were asked if they felt everything had been returned to the same place it was before. Children were permitted to re-position any objects which they felt had been placed incorrectly.

Recording and Scoring Data. - The observer recorded each child's object placements by drawing the placements on a gridded map of the playroom, in which grids corresponded to the tiles on the playroom floor (1 tile = 25 cm. sq.). The correct positions of the 14 objects, as well as the dresser drawers, rug, table, and door to the playroom, were indicated on these maps. In this way, each child's placements could be directly compared with correct placements.

Data from these maps were used to compute location recall scores for each child. The location of an object was designated as exactly correct if it was replaced so that over ½ of its area overlapped with its correct location, and as approximately correct if it did not meet the criterion of exact placement but was replaced within one grid on the map of its correct location.

Results and Discussion

As shown in table 2, the mean number of objects recalled was greater for both older and younger preschoolers when they recalled within the spatial context than when they did not. In fact, the performance of the two age groups did not differ in this condition. This was confirmed by a 2(age) x 2(condition) x 2(sex) analysis of variance, in which a significant mean effect for condition was found, $F(1, 40) = 14.44$, $p=.001$. The main effect for age did not reach significance, $F(1, 40) = 2.03$, n.s., nor did the age x condition interaction, $F(1, 40)=1.22$, n.s. No main effects or interactions involving sex were significant.

Thus, even the youngest preschool children were clearly able to use spatial context to aid their recall when the recall task was presented in a differentiated, naturalistic large-scale environment as part of a meaningful activity. This indicates that spatial context probably functions automatically as a retrieval aid in everyday recall situations, even for very young children.

In fact, we found that children in the No Spatial Context condition very frequently tried to return to the playroom when asked to recall the missing objects, even though they knew the objects were no longer there.

If young children automatically use spatial contexts as a retrieval aid, item identity must be closely associated in memory with item location. The contingency tables presented in table 3 illustrate the extent to which recalled and nonrecalled items were accurately replaced. A significant relationship between object recall and object replacement was found for both the younger group (corrected x^2=19.93, p<.001, C=25)oand the older group (corrected x^2=9.54, p<.01, C=.17). It is clear from an examination of table 3 that although recalled objects were very likely to be replaced correctly, objects that were correctly replaced were not necessarily likely to be recalled. For both age groups, nearly all of objects which were recalled were also correctly replaced. However, because children were much more likely to recall object location than object identity, both age groups failed to recall over 50% of the objects that they replaced either exactly or approximately correctly. This pattern of results, in which object location is recalled better than object identity, has also been found in older children and adults (Dick & Dick, 1969; Finkel, 1973).

The children's excellent recall of object location under the incidental recall conditions presented in this study is further evidence for automatic encoding of spatial location. Although an age(2) x sex(2) analysis of variance on the number of objects children replaced either exactly or approximately correctly indicated a significant main effect for age, $F(1,44) = 4.36$, $p<.05$, even the younger group performed extremely well. They replaced 85% of the objects at least approximately correctly, whereas the older group replaced 93% of the objects at least approximately correctly.

The replacement accuracy found in this study is considerably higher than that found in other studies examining preschool children's memory for object location in large scale environments (cf. Herman & Siegel, 1978; Liben, Moore, & Golbeck, 1982). For example, 3 to 5-year-old children in the Liben et. al. (1982) study replaced only about 58% of the objects in their preschool classroom approximately correctly. The high level of performance in the present study is probably due to the greater availability of topographic information in the environment used in the present study. The objects to be replaced in the present study were probably more distinctive than those in the classroom used by Liben et. al., which contained a number of similar shelves and tables. Also, the space used in the present study was considerably smaller, and contained several topographic landmarks. Thus, each distinctive object could be easily associated with a distinctive location. Because the children were easily able to associate most of the objects with their particular locations, the spatial context of the playroom served as an effective retrieval cue for them.

Children's use of objects was found to be related to their later recall of these objects. The contingency tables presented in table 4 illustrate the relationship between the extent to which objects were used and whether or not they were later recalled. A significant relationship between object use and object recall was found for both the younger group (corrected $x^2=45.31$, $p < .001$, $C=.36$) and the older group (corrected $x^2=30.00$, $p < .001$, $C=.30$). Objects that were used two or more times were very likely to be recalled; however, objects that were recalled were just as likely to have been unused as used.

A similar pattern of results was found for object use and object replacement, as shown in the contigency tables presented in table 5. A significant relationship between object use and object replacement was found for

both the younger group (corrected $\chi^2 = 22.61$, $p < .001$, $C = .26$) and the older group (corrected $\chi^2 = 6.66$, $p < .05$, $C = .14$). Again, objects that were used were very likely to be replaced correctly, but whether or not an object was correctly replaced did not predict whether or not it had been used. Thus, using objects facilitated children's recall of their identities and locations, but was not essential.

GENERAL DISCUSSION

Results of the present studies indicate that even very young children are able to use spatial context relatively automatically and effortlessly to aid their recall of objects encountered within that context. However, the youngest children are able to do so only under conditions which maximize the likelihood that they will automatically encode each object in association with its own distinct spatial location. Such conditions are most likely to be met when children encounter the objects within highly differentiated environments that are rich in topographic features, and when they interact with the objects in the context of meaningful activity.

If young children automatically encode information about object location in the course of meaningful interaction with objects, and if they are able to use spatial contexts as retrieval aids in an effortless, nonstrategic fashion, what sorts of developmental changes might occur in the use of spatial contexts in memory? As we have already suggested, the development of children's abilities to construct route and configurational spatial representations should significantly effect the development of children's organization, retrieval and manipulation of objects in memory. The development of the ability to construct route representations can aid retrieval of information by placing the information to be recalled in a linear sequence. When items are encoded within route

representations, complete recall of items along a route can be obtained by scanning the route from beginning to end. Children who encode only isolated relationships between items and locations have no organizing framework for ensuring that all items will be recalled.

Developmental change probably also occurs in the extent to which objects must be in permanent spatial locations in order for locations to serve as retrieval cues for the objects. This development parallels Huttenlocher's (1974) finding that infants during the second year of life are able to find objects in permanent locations before they are able to find objects in temporary locations. Similarly, children may be able to represent permanent spatial contexts before they are able to represent temporary spatial contexts. Clearly, spatial contexts are of limited usefulness as a mnemonic aid if they are only useful for recalling objects and events with permanent locations.

In recent pilot studies, we have found that adults spontaneously use temporary spatial contexts to organize recall, but children do so only when prompted. In the preschool classes where we conducted the present studies, each of the children sat at a particular table every day to eat snacks. They were at these tables for only 10 minutes a day. The rest of the time, the tables were set up with other activities and the children moved freely from table to table. All of the teachers recalled the children according to their snack tables groups, but even in the presence of the tables, the children never did so. However, the children were able to recall more of their classmates when asked, "Which children sit at this table?" for each of the tables, then when asked to name all the children in their class. Thus, young children do encode temporary spatial locations, but these locations are also associated with numerous other persons, objects, and events, and thus do not serve as automatic retrieval cues.

We might also expect children to develop from needing a spatial context to be actually present during recall, to being able to mentally represent absent spatial contexts. Reliance on actual spatial contexts as a mnemonic aid is of limited value since it is likely that most of the time when people need to recall items associated with a spatial context, the spatial context itself is not present. There is evidence that imagining a spatial context improves adult's recall of information learned in that context (Smith, 1979), but relatively little information exists about when and under what circumstances children develop the ability to mentally represent routes or configurations in order to recall the objects located along routes or within configurations.

In Experiment 1 we found only one older child who clearly invoked a mental representation of the absent array during recall in Condition 1. She quickly named 8 of the 9 pictures, then said, "And there's one more I forgot, between the boat and the duck." She was correct about the location of the one picture she failed to recall. Such a mnemonic feat is obviously rare among preschoolers, but young children may be able to mentally represent very simple routes in order to recall the objects along them. For example, Hazen, Lockman, & Pick (1978) found that most 4-year-olds can recall up to four landmarks using the spatial organization of the simple route along which the landmarks were encountered. Children must develop the ability to organize spatial locations into route or configurational representations in order to use imagined spatial contexts to aid recall, since representations based on isolated relationships between landmarks are of little use in structuring recall when the actual spatial context is not present.

In conclusion, results of the present studies indicate that even very young children automatically encode the locations of items, at least when the

items are located in differentiated environments and the child is engaged in meaningful activity. These conditions are likely to prevail in most naturalistic recall situations. Because young children automatically encode item locations, they are able to use the spatial context in which items were located to facilitate item recall. This basic ability is present from a very early age; however, developments in spatial representation abilities should enable children to use spatial context as a mnemonic aid in an increasing variety of situations. The abilities to use temporary spatial contexts to organize recall, to mentally represent absent spatial contexts, and to organize mental representations of spatial contexts as routes or configurations, would need to be well developed before the child would be capable of using a complex mnemonic strategy such as the method of loci effectively.

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TABLE 1

EXPERIMENT 1: MEANS AND STANDARD DEVIATIONS OF RECALL SCORES AS A FUNCTION OF AGE AND CONDITION

CONDITION	AGE: Younger M	Younger SD	Older M	Older SD
1. Free Recall - Spatial Context Absent	4.57	1.01	4.63	1.04
2. Free Recall - Spatial Context Present	4.56	1.55	6.06	1.08
3. Cued Recall - Spatial Context Present	4.51	1.26	4.61	1.06

TABLE 2

EXPERIMENT 2: MEANS AND STANDARD DEVIATIONS OF RECALL SCORES AS A FUNCTION OF AGE AND CONDITION

	AGE			
	Younger		Older	
CONDITION	M	SD	M	SD
1. Spatial Context Present	5.58	2.27	5.75	1.48
2. Spatial Context Absent	3.00	2.27	4.33	1.97

TABLE 3

RELATIONSHIP BETWEEN OBJECT RECALL AND OBJECT REPLACEMENT

RECALL PERFORMANCE	REPLACEMENT PERFORMANCE: Replaced Exactly Correctly	Replaced Approximately Correctly	Not Replaced Correctly
	Younger		
Object Recalled	N=68 22%	N=32 10%	N=3 1%
Object Not Recalled	N=98 31%	N=66 21%	N=45 14%
	Older		
Object Recalled	N=83 27%	N=32 10%	N=5 1%
Object Not Recalled	N=100 32%	N=72 23%	N=20 6%

TABLE 4

RELATIONSHIP BETWEEN OBJECT USE AND
OBJECT RECALL

RECALL PERFORMANCE	Used 2 or More Times	Used Once	Not Used
		Younger	
Object Recalled	N=34 11%	N=18 6%	N=48 15%
Object Not Recalled	N=14 4%	N=26 18%	N=172 55%
		Older	
Object Recalled	N=30 10%	N=19 6%	N=72 3%
Object Not Recalled	N=8 3%	N=31 10%	N=152 49%

TABLE 5

RELATIONSHIP BETWEEN OBJECT USE

AND OBJECT REPLACEMENT

REPLACEMENT PERFORMANCE	OBJECT USE		
	Used Two or More Times	Used Once	Not Used
		Younger	
Object Replaced Exactly Correctly	N=38 12%	N=25 8%	N=110 35%
Object Replaced Approximately Correctly	N=7 2%	N=18 6%	N=65 21%
Object Replaced Incorrectly	N=3 1%	N=1 0%	N=45 14%
		Older	
Object Replaced Exactly Correctly	N=25 8%	N=26 8%	N=134 43%
Object Replaced Approximately Correctly	N=13 4%	N=21 7%	N=68 22%
Object Replaced Incorrectly	N=0 0%	N=3 1%	N=22 7%